Pre-operative Stroke Increases Risk for Periprosthetic Joint Infection in Total Hip Arthroplasty

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INTRODUCTION:

The disruption of immune mechanisms by ischemic and hemorrhagic stroke has been increasingly recognized over the last decade. Stroke leads to interruption of the blood-brain barrier, destruction of neurons, and damages regulatory pathways between the central nervous system and the adaptive and innate immune systems. This neural network is responsible for the innervation of neuroendocrine glands, lymphoid tissue, and humoral messengers, which are essential in physiologic regulation of the immune system. Immunologic dysregulation has implications with regards to immune response to infection, including the ability to defend against post-operative infection. To date, the pre-operative morbidity of stroke, and its implications for patients undergoing total hip arthroplasty, has not been investigated. Therefore, we evaluated the effect of pre-operative stroke on risk for periprosthetic joint infection (PJI) in THA patients.

METHODS:

We queried the "mhip" dataset in a national, all-payer database to identify patients that underwent primary THA from January 2010 to October 2020 (n=1.97 million). Patients were stratified into five cohorts: stroke treated without blood thinners within six-months (n=8,728) or six-months to one-year (n=4,903) prior to THA, and stroke treated with blood thinners within one-year (n=5,282) or one-year to 18-months (n=1,293) prior to THA, as well as a non-stroke affected, control, cohort (n=25,000). Bivariate chi-square analysis of outcomes were conducted and independent risks were assessed by way of multivariate regressions.

RESULTS: Patients who have suffered a stroke prior to undergoing THA are at increased risk for septic revisions at 90 days, 1 year, and 2 years post-operatively compared to patient who had not suffered a stroke. Furthermore, suffering a stroke 6 months and taking post-stroke anti-coagulation for one year prior to THA increased risk for septic revisions at all time points.

DISCUSSION AND CONCLUSION:

Patients who have suffered a stroke, including patients who had initiated post-stroke anti-coagulation therapy prior to THA, were more likely to develop a PJI compared to patient who did not experience a stroke. Additionally, patients that experienced a stroke and were treated with blood thinners should wait 18 months while those treated without blood thinners should wait one year before undergoing a THA. This study highlights the importance of identifying patients who have suffered a stroke prior to THA and optimizing immune system regulation in an effort to prevent PJI.

Table 1. Demographics and Characteristics

	Control (n=25,000)	Stroke w/o BT 1 yr prior to THA (n=4,903)	Stroke w/o BT 6 m prior to THA (n=8,728)	Stroke with BT 1 year prior to THA (n=5,282)	Stroke with BT 18 m prior to THA (n = 1,293)	*p*-value
Age (SD)	65 (10.27)	68 (8.99)	69 (8.89)	68 (8.89)	68 (8.49)	
Sex						<0.001
Female	14,114 (56.58%)	2,863 (58.39%)	5,017 (57.48%)	3,169 (54.43%)	710 (54.91%)	
Male	10,856 (43,42%)	2,040 (41,61%)	3,711 (42.52%)	2,653 (45.57%)	583 (45.09%)	
AA	1868 (7.47%)	468 (9.55%)	820 (9.40%)	633 (10.87%)	132 (10.21%)	<0.001
CCI > 3	2928 (11.71%)	2349 (47.91%)	4213 (48.27%)	3378 (58.02%)	766 (59.24%)	<0.001
DM	9439 (37.76%)	2406 (49.07%)	4230 (48.46%)	3384 (58.12%)	756 (58.47%)	<0.001
Obesity	10014 (40.06%)	1764 (35.98%)	2991 (34.27%)	2624 (45.07%)	559 (43.23%)	<0.001
TU	10086 (40.34%)	2266 (46.22%)	3879 (44.44%)	3062 (52.59%)	675 (52.20%)	<0.001

SD: Standard deviation; BT: blood thinner; Yr: year; Wks: weeks; M: months;
AA: Alcohol Abuse; CCI: Charlson Comorbidity Index; DM: Diabetes Mellitus; TU: Tobacco Use;

Table 2. Bivariate Analysis of Post-Operative Outcomes

	Control (n=25,000)	**Stroke w/o BT 1 yr prior to THA (n=4,903)**	**Stroke w/o BT 6 m prior to THA (n=8,728)**	**Stroke with BT 1 year prior to THA (n=5,282)**	**Stroke with BT 18m prior to THA (n = 1,293)**	***p*-value**
90-day Complications						
Blood Transfusion	152 (0.61%)	55 (1.12%)	111 (1.27%)	79 (1.36%)	20 (1.55%)	<0.001
Cardiac Arrest	22 (0.09%)	* (*)	24 (0.27%)	16 (0.27%)	* (*)	<0.001
CVA	48 (0.19%)	85 (1.73%)	447 (5.12%)	333 (5.72%)	33 (2.55%)	<0.001
Dislocation	295 (1.18%)	130 (2.65%)	195 (2.23%)	121 (2.08%)	25 (1.93%)	<0.001
DVT	418 (1.67%)	134 (2.73%)	278 (3.19%)	205 (3.52%)	39 (3.02%)	<0.001
MC	159 (0.64%)	54 (1.10%)	94 (1.08%)	76 (1.31%)	19 (1.47%)	<0.001
MI	62 (0.25%)	33 (0.67%)	56 (0.64%)	61 (1.05%)	17 (1.31%)	<0.001
PE	158 (0.63%)	55 (1.12%)	87 (1.00%)	97 (1.67%)	22 (1.70%)	<0.001
septic revision	228 (0.91%)	62 (1.26%)	140 (1.60%)	114 (1.96%)	19 (1.47%)	<0.001
PNA	306 (1.22%)	136 (2.77%)	296 (3.39%)	171 (2.94%)	37 (2.86%)	<0.001
RF	152 (0.61%)	71 (1.45%)	181 (2.07%)	95 (1.63%)	24 (1.86%)	<0.001
PPFx	123 (0.49%)	34 (0.69%)	68 (0.78%)	36 (0.62%)	* (*)	0.022
Aseptic Revision	206 (0.82%)	61 (1.24%)	101 (1.16%)	72 (1.24%)	12 (0.93%)	0.002
SSI	379 (1.52%)	110 (2.24%)	225 (2.58%)	164 (2.82%)	26 (2.01%)	<0.001
1-year Complications						
Dislocation	383 (1.53%)	144 (2.94%)	246 (2.82%)	156 (2.68%)	33 (2.55%)	<0.001
MC	143 (0.57%)	50 (1.02%)	95 (1.09%)	66 (1.13%)	12 (0.93%)	<0.001
septic revision	282 (1.13%)	74 (1.51%)	164 (1.88%)	140 (2.40%)	24 (1.86%)	<0.001
PPFx	152 (0.61%)	43 (0.88%)	96 (1.10%)	53 (0.91%)	* (*)	<0.001
Aseptic Revision	311 (1.24%)	86 (1.75%)	174 (1.99%)	105 (1.80%)	16 (1.24%)	<0.001
SSI	466 (1.86%)	143 (2.92%)	287 (3.29%)	219 (3.76%)	39 (3.02%)	<0.001
2-year Complications						
Dislocation	370 (1.48%)	138 (2.81%)	243 (2.78%)	151 (2.59%)	37 (2.86%)	<0.001
MC	230 (0.92%)	75 (1.53%)	135 (1.55%)	97 (1.67%)	19 (1.47%)	<0.001
septic revision	304 (1.22%)	76 (1.55%)	170 (1.95%)	152 (2.61%)	27 (2.09%)	<0.001
PPFx	196 (0.78%)	71 (1.45%)	126 (1.44%)	78 (1.34%)	16 (1.24%)	<0.001
Aseptic Revision	388 (1.55%)	104 (2.12%)	209 (2.39%)	124 (2.13%)	17 (1.31%)	<0.001
SSI	538 (2.15%)	165 (3.37%)	326 (3.74%)	255 (4.38%)	45 (3.48%)	<0.001

BT: blood thinner; W/o: without; Yr: year; Wks: weeks; M: months; CVA: Cerebrovascular Accident; DVT: Deep Venous Thrombosis; MI: Myocardial Infarction; PE: Pulmonary Embolism; PJI: Prosthetic Joint Infection; PNA: Pneumonia; RF: Renal Failure; MC: mechanical complication; PPFx: Periprosthetic Fracture; SSI: Surgical Site Infection

Table 3. Odds Ratio of Complications

	Stroke w/o BT 1 yr prior to THA		**Stroke w/o BT 6 m prior to THA**		**Stroke with BT 1 year prior to THA**		**Stroke with BT 18m prior to THA**	
	OR	**95% CI**	**OR**	**95% CI**	**OR**	**95% CI**	**OR**	**95% CI**
90-day Complications								
Blood Transfusion	1.85	1.36-2.53	2.11	1.65-2.69	2.25	1.71-2.96	2.57	1.61-4.11
Cardiac Arrest	1.86	0.83-4.17	3.13	1.75-5.59	3.13	1.64-5.96	3.52	1.21-10.24
CVA	9.17	6.43-13.08	28.06	20.81-37.83	31.54	23.27-42.74	13.61	8.71-21.28
Dislocation	2.28	1.85-2.81	1.91	1.59-2.30	1.78	1.44-2.20	1.65	1.09-2.49
DVT	1.65	1.36-2.01	1.93	1.66-2.26	2.15	1.81-2.54	1.83	1.31-2.55
MC	1.74	1.28-2.37	1.7	1.32-2.20	2.07	1.57-2.72	2.33	1.44-3.76
MI	2.73	1.78-4.16	2.6	1.81-3.73	4.26	2.99-6.07	5.36	3.12-9.19
PE	1.78	1.31-2.43	1.58	1.22-2.06	2.66	2.07-3.44	2.72	1.74-4.27
septic revision	1.39	1.05-1.85	1.77	1.43-2.19	2.17	1.73-2.72	1.62	1.01-2.60
PNA	2.3	1.88-2.82	2.83	2.41-3.33	2.44	2.02-2.95	2.38	1.68-3.36
RF	2.4	1.81-3.19	3.46	2.79-4.30	2.71	2.10-3.51	3.09	2.00-4.77
PPFx	1.41	0.96-2.07	1.59	1.18-2.14	1.26	0.87-1.83	0.79	0.32-1.92
Aseptic Revision	1.52	1.14-2.02	1.41	1.11-1.79	1.51	1.15-1.97	1.13	0.63-2.02
SSI	1.49	1.20-1.85	1.72	1.45-2.03	1.88	1.56-2.27	1.33	0.89-1.99
1-year Complications								
Dislocation	1.94	1.60-2.36	1.86	1.59-2.19	1.77	1.47-2.14	1.68	1.17-2.41
MC	1.79	1.30-2.47	1.91	1.47-2.48	1.99	1.49-2.67	1.63	0.90-2.94
septic revision	1.34	1.04-1.74	1.68	1.38-2.04	2.16	1.76-2.65	1.66	1.09-2.52
PPFx	1.45	1.03-2.03	1.82	1.41-2.35	1.5	1.10-2.06	0.89	0.42-1.90
Aseptic Revision	1.42	1.11-1.80	1.61	1.34-1.95	1.46	1.17-1.82	0.99	0.60-1.65
SSI	1.58	1.31-1.91	1.79	1.54-2.08	2.06	1.75-2.42	1.64	1.18-2.28
2-year Complications								
Dislocation	1.93	1.58-2.35	1.91	1.62-2.25	1.77	1.46-2.15	1.96	1.39-2.76
MC	1.67	1.29-2.18	1.69	1.37-2.10	1.82	1.44-2.32	1.61	1.00-2.57
septic revision	1.28	0.99-1.65	1.61	1.34-1.95	2.18	1.79-2.65	1.73	1.16-2.58
PPFx	1.86	1.41-2.44	1.85	1.48-2.32	1.72	1.32-2.24	1.59	0.95-2.65
Aseptic Revision	1.37	1.10-1.71	1.56	1.31-1.84	1.38	1.13-1.69	0.85	0.52-1.38
SSI	1.58	1.33-1.89	1.76	1.53-2.03	2.08	1.79-2.42	1.64	1.20-2.23

*Referent cohort: control.
BT: blood thinner; Yr: year; Wks: weeks; M: months; CVA: Cerebrovascular Accident; DVT: Deep Venous Thrombosis; MI: Myocardial Infarction; PE: Pulmonary Embolism; PJI: Prosthetic Joint Infection; PNA: Pneumonia; RF: Renal Failure; MC: mechanical complication; PPFx: Periprosthetic Fracture; SSI: Surgical Site Infection

Table 4. Multivariate Logistic Regression for septic revision

90-day septic revision	**OR**	**95% CI**	***p*-value**
Male	1.09	1.04-1.13	<0.001
Age< 60	1.51	0.24-5.01	0.570
Alcohol Use	1.75	1.36-2.21	<0.001
Diabetes Mellitus	1.13	1.00-1.28	0.049
Glucocorticoid Use	0.97	0.80-1.16	0.730
Obesity	2.25	1.95-2.59	<0.001
Tobacco Use	1.24	1.08-1.43	0.002
Blood Thinner 1 year prior to THA*	1.67	1.32-2.11	<0.001
Blood Thinner 18m Prior to THA*	1.26	0.77-1.94	0.320
Stroke 1 year Prior to THA*	1.43	0.80-2.35	0.190
Stroke 6 m Prior to THA*	1.40	1.17-1.67	<0.001
1-year septic revision			
Male	1.09	1.06-1.14	<0.001
Age< 60	1.31	0.21-4.29	0.714
Alcohol Use	1.70	1.35-2.11	<0.001
Diabetes Mellitus	1.11	0.99-1.24	0.073
Glucocorticoid Use	0.99	0.84-1.16	0.903
Obesity	2.1	1.84-2.39	<0.001
Tobacco Use	1.26	1.11-1.43	<0.001
Blood Thinner 1 year prior to THA*	1.70	1.37-2.11	<0.001
Blood Thinner 18m Prior to THA*	1.32	0.86-1.95	0.178
Stroke 1 year Prior to THA*	1.53	0.92-2.38	0.077
Stroke 6 m Prior to THA*	1.36	1.15-1.60	<0.001
2-year septic revision			
Male	1.11	1.08-1.15	<0.001
Age< 60	1.29	0.21-4.22	0.730
Alcohol Use	1.62	1.29-2.01	<0.001
Diabetes Mellitus	1.08	0.97-1.20	0.164
Glucocorticoid Use	1.02	0.87-1.19	0.772
Obesity	2.08	1.82-2.36	<0.001
Tobacco Use	1.29	1.14-1.45	<0.001
Blood Thinner 1 year prior to THA*	1.73	1.41-2.12	<0.001
Blood Thinner 18m Prior to THA*	1.37	0.91-1.97	0.110
Stroke 1 year Prior to THA*	1.48	0.90-2.28	0.093
Stroke 6 m Prior to THA*	1.30	1.10-1.52	0.002

*Referent group: control
THA: Total Knee Arthroplasty; Yr: year; Wks: weeks; M: months;

Table 5. Multivariate Logistic Regression for Aseptic Revision

90-day Aseptic Revision	**OR**	**95% CI**	***p*-value**
Male	0.64	0.61-0.67	<0.001
Age< 60	0.75	0.04-3.47	0.780
Alcohol Use	1.57	1.16-2.06	0.002
Diabetes Mellitus	0.92	0.80-1.05	0.234
Glucocorticoid Use	1.12	0.93-1.34	0.220
Obesity	0.98	0.80-1.19	0.860
Tobacco Use	1.24	1.06-1.44	0.006
Blood Thinner 1 year prior to THA*	1.15	0.86-1.51	0.330
Blood Thinner 18m Prior to THA*	0.84	0.45-1.42	0.550
Stroke 1 year Prior to THA*	0.54	0.19-1.17	0.170
Stroke 6 m Prior to THA*	1.03	0.84-1.26	0.761
1-year Aseptic Revision			
Male	0.69	0.67-0.72	<0.001
Age< 60	1.75	0.42-4.83	0.349
Alcohol Use	1.84	1.47-2.27	<0.001
Diabetes Mellitus	0.93	0.83-1.04	0.191
Glucocorticoid Use	1.07	0.91-1.24	0.406
Obesity	0.95	0.80-1.11	0.522
Tobacco Use	1.25	1.11-1.42	<0.001
Blood Thinner 1 year prior to THA*	1.14	0.90-1.43	0.262
Blood Thinner 18m Prior to THA*	0.74	0.43-1.18	0.241
Stroke 1 year Prior to THA*	0.93	0.51-1.54	0.783
Stroke 6 m Prior to THA*	1.19	1.01-1.39	0.033
2-year Aseptic Revision			
Male	0.74	0.71-0.76	<0.001
Age< 60	1.49	0.36-4.08	0.507
Alcohol Use	1.71	1.39-2.09	<0.001
Diabetes Mellitus	0.91	0.82-1.01	0.071
Glucocorticoid Use	1.09	0.95-1.25	0.201
Obesity	0.96	0.83-1.11	0.617
Tobacco Use	1.27	1.13-1.42	<0.001
Blood Thinner 1 year prior to THA*	1.10	0.89-1.36	0.364
Blood Thinner 18m Prior to THA*	0.66	0.39-1.03	0.087
Stroke 1 year Prior to THA*	1.14	0.69-1.74	0.584
Stroke 6 m Prior to THA*	1.20	1.03-1.38	0.016

*Referent group: control
THA: Total Knee Arthroplasty; Yr: year; Wks: weeks; M: months;